

DOMINANCE RELATIONSHIPS OF THE DARK KANGAROO MOUSE (*MICRODIPODOPS MEGACEPHALUS*) AND THE LITTLE POCKET MOUSE (*PEROGNATHUS LONGIMEMBRIS*) IN CAPTIVITY

Andrew R. Blaustein¹ and Arthur C. Risser, Jr.¹

ABSTRACT.—Interspecific interactions between the little pocket mouse (*Perognathus longimembris*) and the dark kangaroo mouse (*Microdipodops megacephalus*) were tested in the laboratory. *P. longimembris* was statistically dominant over *M. megacephalus*. The dominant-subordinate relationships shown by our laboratory results indicate that interspecific aggression may be one mechanism involved in keeping these sympatric species ecologically separated.

In certain areas of northern Nevada, the dark kangaroo mouse (*Microdipodops megacephalus*) and the little pocket mouse (*Perognathus longimembris*) are sympatric (Hall and Kelson, 1959). These species are similar in size and, being primarily granivorous (Hall, 1946), probably have similar feeding habits. As compared with what is known about other members of their family (Heteromyidae), little is known about the ecology of these species. This study investigates the possibility that interspecific agonistic behavior may be a mechanism by which ecological isolation occurs between these two species in the field. To assess this possibility we observed interspecific interactions between pairs of captive *M. megacephalus* and *P. longimembris*. The possible role of interspecific agonistic behavior in the habitat segregation of small mammals has been reviewed by Grant (1972).

Three *Microdipodops* (two females and one male) and four *Perognathus* (two females and two males) were trapped in Warm Springs Valley, Washoe Co., Nevada. The animals were caged individually in steel cages measuring 34 x 24 x 24 cm. The front of each cage was covered with 1 x 1.25-inch hardware mesh. Sand one centimeter deep was placed in each cage. The cages were cleaned periodically. A mixture of sunflower seeds, rolled oats, and millet was given to the animals daily. Lettuce was provided once a week. No water was provided. The housing cages were placed under a 12-hour light—12-hour dark controlled photoperiod. The light and dark periods were reversed, allowing these normally nocturnal animals to be observed during convenient daytime sessions. The light phase was illuminated by two incandescent 60-watt white light bulbs, and the dark phase was slightly illuminated by two incandescent 25-watt red light bulbs.

Encounters took place in a cage measuring 34.5 x 45.7 x 122 cm. Three sides of the cage were aluminum, and the front was plexiglas. The top was covered with .25-inch hardware cloth, and an aluminum partition divided the cage into two equal sections, each

¹Andrew R. Blaustein and Arthur C. Risser, Jr., Department of Biology, University of Nevada, Reno 89507. Present address of Blaustein: Department of Biological Sciences, University of California, Santa Barbara 93106.

containing a nesting area and a food dish. Two cm of sand covered the floor of the cage and was replaced after each interaction.

To begin an interaction, one rodent was placed on each side of the central partition. The cage was subjected to the same reversed photoperiod as the housing cages. The animals were left alone for at least 24 hours as an adjustment period. Then the partition was removed, and the behavior and interrelationships of the rodents were recorded for 15 minutes. Interactions with the same two individuals were not repeated. At least two days were allowed to elapse before an individual was used again. All trials were conducted between 1000 hr and 1500 hr.

Any overt interaction between two animals was called an encounter. Agonistic encounters usually ended when one animal took the dominant role by attacking and chasing its opponent and the other became subordinate by escaping or trying to defend its nest area from attack.

The behavioral patterns and postures observed between the mice were classified into five major categories. These have been modified from Eisenberg (1963).

Upright posture.— The animal assumes a posture with the long axis of the body at an angle greater than 45 degrees to the substrate.

Rushing.— The animal usually has an elongated posture. The ears are erect and the eyes are wide open. When the opponent is reached, the animal may strike at it with its forepaws. This is the major aggressive movement.

Chase.— The animal runs after the opponent and tries to bite its rump.

Nest defense.— This usually involves an upright posture in defending a nest area from an opponent. It may involve short elongate rushes whereby the defender rushes in short spurts, not straying far from its nest area.

Escape leap.— Wild erratic jumps are used to escape a rush or subsequent chase.

Fighting usually began within the first two minutes after the partition was lifted and was initiated by *P. longimembris* in 11 of 12 interactions. The predominant patterns during interactions were rushing by *Perognathus* and escape leaping by *Microdipodops*. *Perognathus* was usually deliberate in rushing *Microdipodops* and when moving away it assumed a slow quadrupedal gait. *Microdipodops* defended its nest area vigorously during interactions but was usually driven away by *Perognathus*. Rushing by *Perognathus* also induced *Microdipodops* to defend its nest area via an upright stance or via a partial rush; that is, *Microdipodops* started to rush *Perognathus* but stopped short, not advancing far from its nest area. If *Microdipodops* escape leaped, *Perognathus* usually moved away or, rarely, chased *Microdipodops*. If *Microdipodops* defended its nest area, *Perognathus* would usually move away only to return several

seconds later, rush *Microdipodops* and take over its nest area. *Microdipodops* only entered the *Perognathus* half of the cage after they were rushed or chased. Although Eisenberg (1963) noted chasing and locking fight (two animals meet and lock together by gripping with all four limbs) to be quite common between pocket mice intra-specifically, chasing was not frequent and locking fight did not occur in the present study. During interactions both species squealed in high-pitched tones. However, *Microdipodops* vocalized more often and this usually occurred when defending a nest area.

During 12 interactions of all combinations of sex pairings between *Microdipodops* and *Perognathus*, *P. longimembris* was dominant 11 times (Table 1). In one interaction involving a female of each species, neither individual was clearly dominant over the other. In all other cases, *Perognathus* was clearly dominant regardless of sex. *Perognathus* was equally dominant in both halves of the cage. Since each individual was used in more than one trial, the Mann-Whitney U test (Wilcoxon's two-sample test) was utilized to determine whether *P. longimembris* is significantly dominant over *M. megacephalus*. The Mann-Whitney U test in this case can be computed as the number of times a *P. longimembris* was dominant over *M. megacephalus* out of the 12 possible combinations (see Sokal and Rohlf, 1969). In this case, the "U" of the Mann-Whitney U test is either 0 or 1; the probability of this occurring if there is no difference between the species is either $\frac{1}{35}$ or $\frac{2}{35}$ ($1 < P < 2$). Thus, *P. longi-*

membris is significantly dominant over *M. megacephalus*. How does this compare with Grant's (1972) generalization that larger species are usually dominant over smaller species? We decided to compare differences in weights between the two species by utilizing Student's t test for the difference between mean weights and found that *P. longimembris*, the dominant species, was significantly lighter ($P < 0.05$; $N=4$, $\bar{X}=7.38g$, $SE\pm0.69$) than *Microdipodops* ($N=3$, $\bar{X}=10.5g$, $SE\pm0.88$).

The dominant-subordinate relationships between these two species may be a mechanism by which these species are ecologically separated in the field. O'Farrell's (1973) population study of the desert rodents in the same area where we collected our experimental ani-

TABLE 1. Dominance relationships in *Microdipodops megacephalus* (Mm)—*Perognathus longimembris* (Pl) interactions. Percentages are in parentheses. dom=dominant

Combination	Number of interactions	Mm-dom	Pl-dom	None-dom
Male Mm-Female Pl	2	0	2	0
Male Mm-Male Pl	2	0	2	0
Female Mm-Male Pl	4	0	4	0
Female Mm-Female Pl	4	0	3	1
Totals	12	0	11 (91.7)	1 (8.3)

mals lends credence to this idea. His data show that on a 2.7 hectare grid *M. megacephalus* emerged in early March and steadily increased until the middle of April. Towards the end of April, a steady decline of *Microdipodops* corresponded with the emergence and increase in numbers of *P. longimembris*. During the summer very few *Microdipodops* were captured and *Perognathus* covered the entire grid. In September *Perognathus* activity declined and *Microdipodops* activity again increased. Throughout the spring and fall, the centers of activity of the two species did not overlap. Thus, they were spatially isolated. O'Farrell (1973) believes that *P. longimembris* is the more general species and occupies a broader niche than *Microdipodops* because it was found on all habitat types on the grid while *Microdipodops* was generally restricted to areas of fine, loose sand. Furthermore, O'Farrell (1973) believes that *M. megacephalus* probably occupies an included niche within the fundamental niche of *P. longimembris* (see Miller, 1967, for terminology). An interesting situation may exist in Warm Springs Valley because the more general species (*P. longimembris*) appears to be competitively superior to the specialized species (*M. megacephalus*). This is not common, according to Miller (1967). He stated that if there are two sympatric species one of which occupies a smaller included niche within the broader niche of the other, then for coexistence to continue, the species occupying the smaller niche must be the superior competitor.

How, then, has *Microdipodops* avoided extinction? The answer to this question lies in the temporal aspects of the niches of the two species. As stated above, O'Farrell (1973) found that *P. longimembris* is active primarily during the summer while *M. megacephalus* is active primarily during the spring and the fall. Thus, temporally, *P. longimembris*, the superior competitor, has the narrower niche; and if a time axis were included in *Microdipodops*'s fundamental niche, this species niche would not be totally within the fundamental niche of *P. longimembris*. Presumably, *M. megacephalus* would not show decreased summer activity if *P. longimembris* were absent. When the temporal components of the niche are taken into account, it is seen that this system may conform to Miller's (1967) generalization. The dominant-subordinate relationships shown by our laboratory results and the fact that *M. megacephalus* apparently becomes rare as *Perognathus* increases in summer may indicate that interspecific aggression is one mechanism by which ecological isolation is maintained between *P. longimembris* and *M. megacephalus* in the field.

We would like to thank Drs. Fred A. Ryser, Jr., and Beatrice Gardner (University of Nevada, Reno) for critically reviewing early drafts of the manuscript. Dr. Michael J. O'Farrell (Savannah River Ecology Laboratory) critically reviewed an earlier draft of the manuscript and allowed us access to some of his unpublished data. For this we wish to express our appreciation. Dr. Allan Oaten (University of California, Santa Barbara) helped with the statistical analysis of the data. Special thanks go to Dr. Stephen I. Rothstein

(University of California, Santa Barbara) for critically reviewing the manuscript and offering many helpful suggestions.

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